

# **DRAM Market: A Rollercoaster Ride**

Name: Sherry L. Garber  
and  
Bob Merritt

Company: Semico Research Corp.



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# Semico Methodology

- Economy
  - Macro View
- Systems
  - Applications Drive the Market
- Market by Segment
  - SIA Categories
- Devices
  - Interdependence
- Manufacturing
  - Foundry/Capacity

# The Economy Slows

- Overall economy showing signs of a slowing on the consumer sector, particularly in Autos
- Semiconductor industry growth is slowing
- All IC product markets will grow at half the 2000 rate
- Supply supply side of equation
  - Plant delays or cancelled
  - Equipment deliveries pushed out
- Prices are weakening
- End markets remain strong through 2001 but will grow at a slower rate

# The Golden Age for the Economy

- 120+ Months of Expansion
  - Inflation is up primarily due to energy
  - Unemployment hovering at 4%
  - Record Federal surplus projections
  - Productivity continues to increase
  - Asia in expansion
  - Dollar high compared to other currencies
  - GDP slowed faster than expected in 2<sup>nd</sup> half 2000

# Economic News

- Signs of slowing Consumer Sector
  - *Housing starts recover to 1.53 million after hitting their lows in June of 2000, but still off the high of Feb. at 1.82*
  - *Non-farm payrolls rose by 94,000 jobs in November, Employment was stronger in the 1<sup>st</sup> half of 2000 than the 2<sup>nd</sup> half*
  - *Unemployment was 4.0% in November 2000*
  - *Durable orders decreased 5.5% in October to \$209B*
    - *Transportation down 15.8%*
    - *Electronics down 9.9%*
    - *Primary metal down 3.2%*
- Economy growing a little slower

# Important DRAM Markets

- Servers
  - NAS, Cache, Print, All-in-One
- PCs
  - Desktop, Notebook and Handheld PCs
- Communications
  - Switches, Hubs, Routers, ATM Switches, Set Top Box
- Wireless Communication
  - Cellular Base Stations, 3G Cell Phones, Smart Phones
- Consumer
  - Digital Camera, Video Games, Internet Appliances

# End Market Growth Forecasts for 2001

- Desktop PC +10.9%
- Notebooks +26%
- Servers +22%
- Workstation +11%
- Printers +11%
- Switches +35%
- Routers +14%
- Handheld PCs 19%
- Smart Phones +96%
- Base Station +40%
- Digital Cameras +41%
- HDTV +186%
- Video Games +18%

# Resulting Shift in Semiconductor Product Strategies

- Influence of high-end PCs is decreasing
  - High-end PC growth is declining
  - Consumer trend is toward low-end PCs
  - Business trend is toward portability
- Increased emphasis on expanding the capacity of communications systems
- Increased emphasis on Embedded Processor Applications



# Quarter DRAM Review

- The good news of strong second and third quarter revenue was lessened by the downward ASP trend in September
  - Aggregate ASPs drop by 8.7 percent between August and September
- 3Q00 Revenue Up 18.8%
  - July and August revenue and unit shipments strong
  - September Revenue down 15%
- 3Q00 Unit shipments drop 5.0%
  - September Unit shipments down 7%
- Lowest bit growth rate (63.5 percent) since 1993

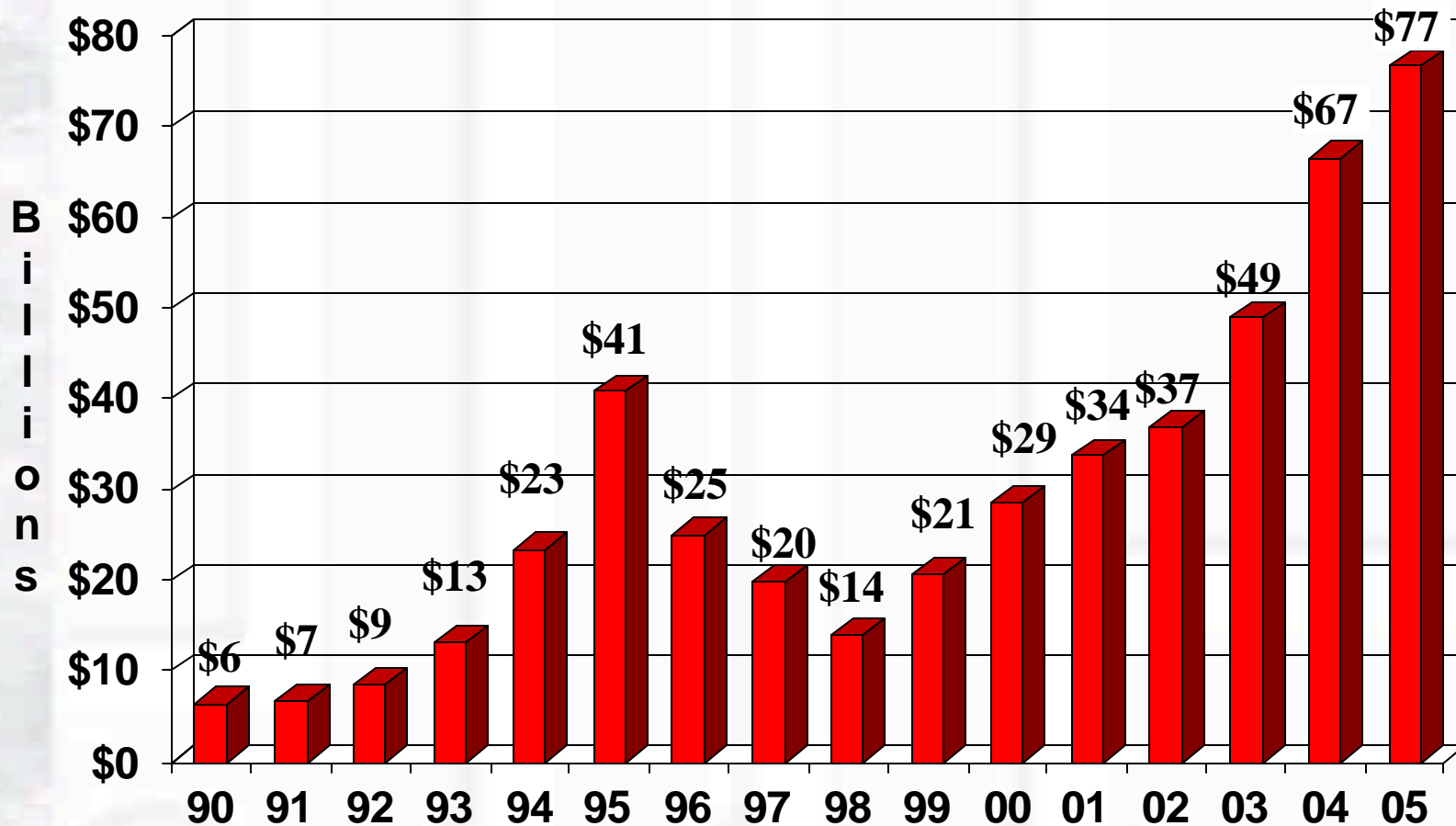
# 2000 Recap

- 2000 Grew to \$28.6 Billion - 38% increase
  - Tight supply in second quarter turned by September to oversupply – forecast to continue through 1Q01
  - Desktop PC memory size holds at 128 megabytes
- Fourth Quarter revenue plummeted 33%
  - ASPs plunged and demand disappeared
- First Quarter revenue forecast to be flat
  - ASPs and Unit shipments stabilize
- High demand in 2Q00 through August was inventory build-up to hedge against potential 2H00 higher prices

# 2001 Revenue Forecast

- 2001 forecast 18.5% Growth – \$33.8 Billion
  - **2001** does not yet exceed revenue high of 1995
    - ASPs stable to up as mix, demand and controlled capacity cause shortages
    - Capacity additions will be scrutinized by most DRAM vendors and delayed
    - Capacity additions already planned cannot be added quickly enough to impact the market until 2H01
    - Diversification of DRAM market to impact supply
      - EDO, SDRAM, DDR SDRAM and RDRAM all in production

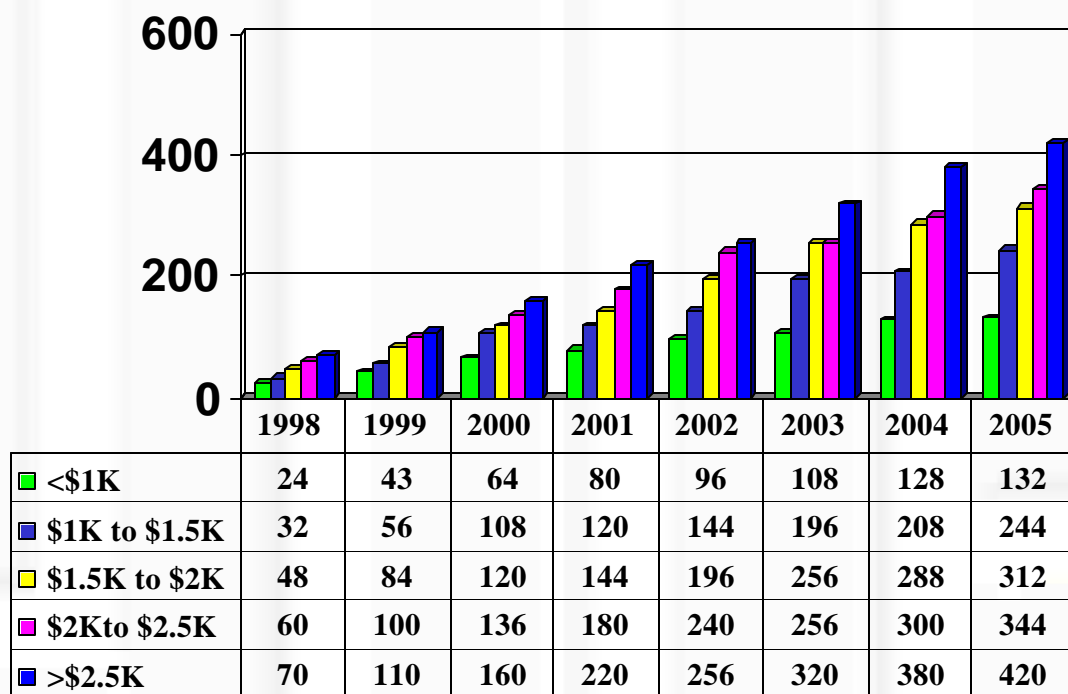
# Worldwide DRAM Market Revenue



# PC Memory

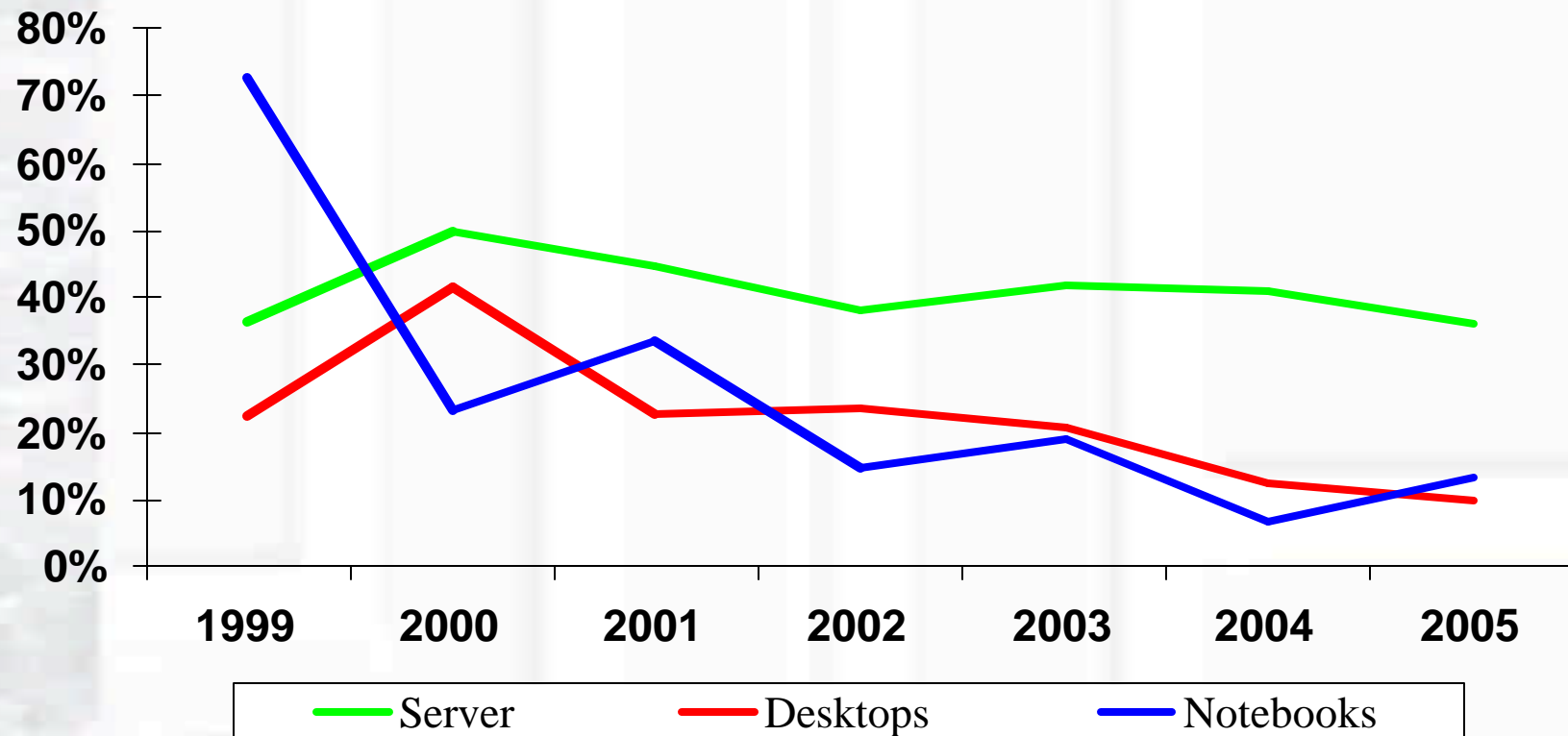
- Desktop PC memory sizes not doubling yearly
  - Price points are key to memory size
- Notebook PCs are becoming nearly comparable to desktops in features
- Sub-portable or Handheld memory sizes are growing also
- Server Memory growing fastest

# Desktop PC Average Memory

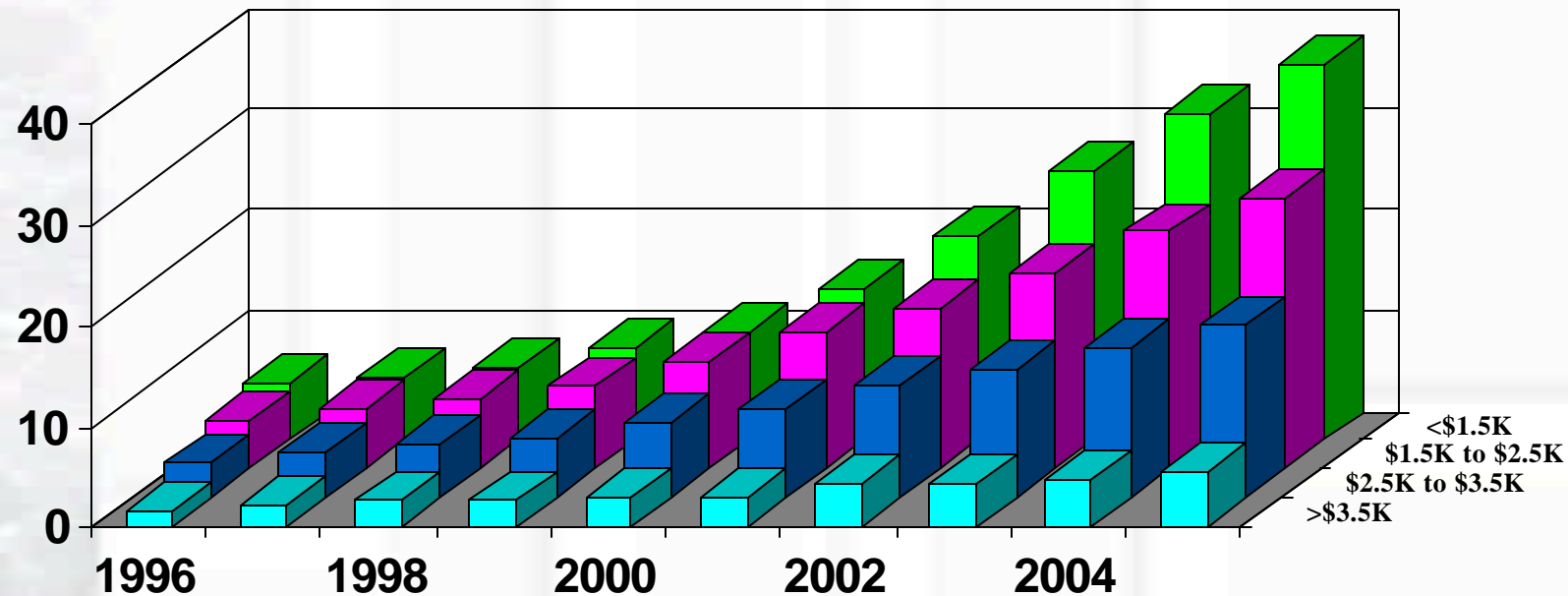


■ <\$1K 
 ■ \$1K to \$1.5K 
 ■ \$1.5K to \$2K 
 ■ \$2Kto \$2.5K 
 ■ >\$2.5K

# Percent Change of Average Megabytes per System

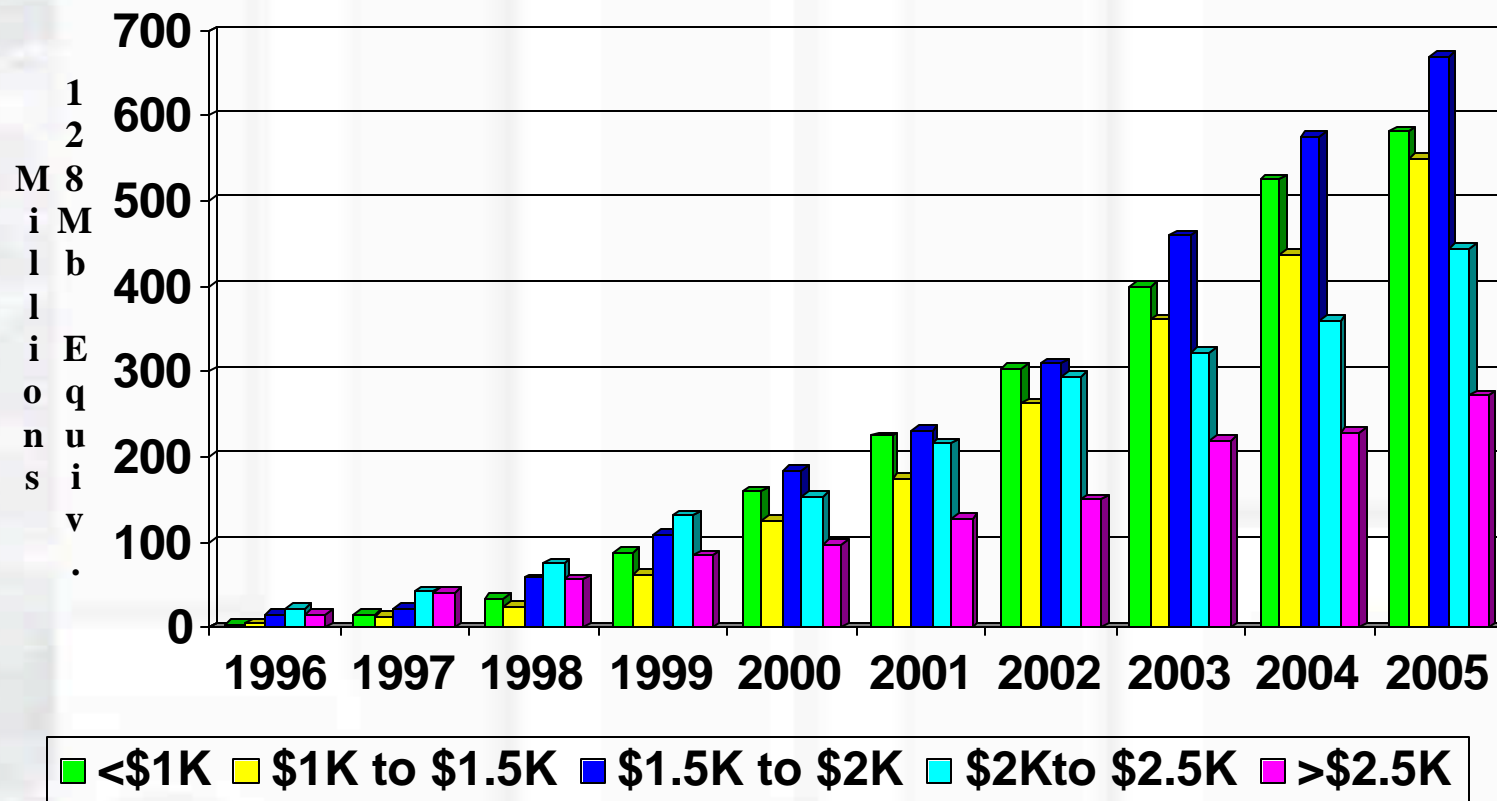


# Desktop Shipments by Price Point





# 128Mbit Consumption by Desktop Price Point



# PC Platform Trends - Chipsets Merge with Graphics

- Driven by further reduction in PC component count
- High performance graphics requires separate components

	Intel	Intel	Intel	ALi	SiS	SiS	VIA	VIA	Nvidia
<b>Part Name</b>	810e	815e	Almador	TNT2	315	730S	KM133	PM133	N/A
<b>South Bridge</b>	ICH2	ICH2	ICH2	1535D	960	960	82C686	82C686	N/A
<b>PC Target</b>	Low-end desktop	Mid-range desktop	Low-end desktop	Mid-range desktop	Low-end desktop	Mid-range desktop	Mid-range desktop	Mid-range desktop	Mid-range desktop
<b>Processor</b>	Celeron	PIII	PIII	PIII	PIII	Athlon	Athlon	PIII	PIII
<b>Graphics Engine</b>	Intel 740	Intel 740	Intel 740	Nvidia Riva	Internal Design	Internal Design	S3 Savage4	S3 Savage4	Nvidia GeForce
<b>Memory</b>	PC100	PC133	PC133	PC133	DDR	PC133	PC133	PC133	DDR
<b>Status</b>	Avail.	Avail.	2Q01	Avail.	1Q01	Avail.	Avail.	Avail.	2Q01

# PC Platform Trends - Support of IEEE1394

- Competition between 1394 and USB heightened by the merger of data and entertainment for home networks
- Issue is the future architectural structure of home networks
  - 1394 supports a peer-to-peer structure with a passive bus
  - USB supports a hierarchical structure with a PC-like host to arbitrate bus usage

# PC Platform Trends - SDRAM Developments Continue

- All Chipset manufacturers now have PC133 and DDR support on their roadmap
- Servers and most PC segments have Chipset support for PC133 or DDR
  - Pentium 4/DDR is announced for servers but not for PCs, but DDR support should be announced in the near future
- SDRAM continues to have the lowest cost/bit

# Chipset Progress - Consumers Wait For DDR

- Intel data on 815/PC133 and 820/RDRAM shows no compelling reason for RDRAM with P3
- Athlon introduced with DDR
- Intel is introducing P4 with RDRAM but hints at DDR support for consumer PCs
- VIA, ALI, SIS chipsets available 1Q01 for P3/DDR
- P4/DDR chipsets could be made available quickly, but are not yet licensed by Intel

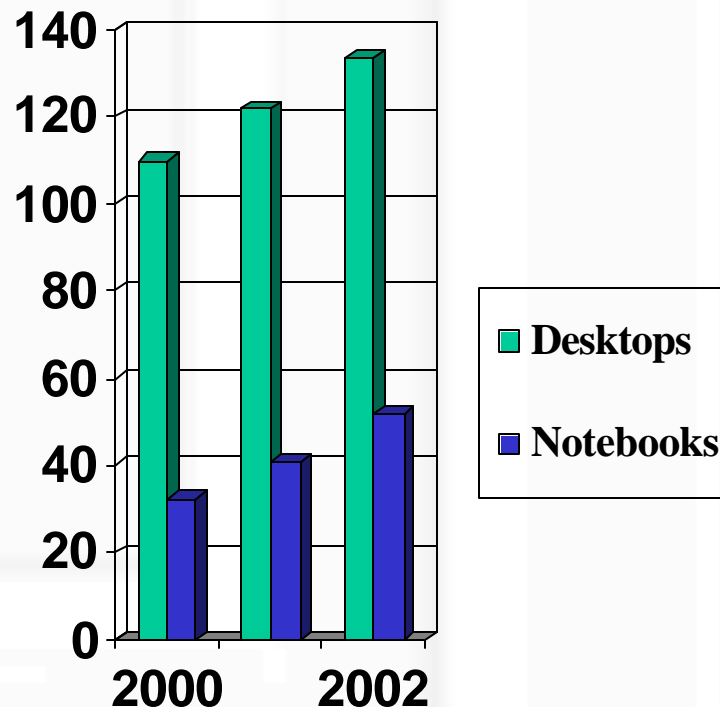
# DRAM Availability Will Not Be a Critical Issue

- Overall memory supply is positive
- DDR is a natural evolution of SDRAM
- It is reasonably simple for DRAM companies to manufacture both PC133 and DDR
- DDR is metal mask option of PC133 in many cases

# PC Platform Drivers for 2001 and 2002

- PC growth slows down
  - New applications restricted by external data rates
- Rollout of Pentium 4
  - Displacement of Pentium 3 by .13 micron Pentium 4

# PC Growth Slows



- Forecast of combined growth of Desktop and Notebook is 14.3% in 2001 and 14.1% in 2002
- Fastest growth rate is in the lower performance segments



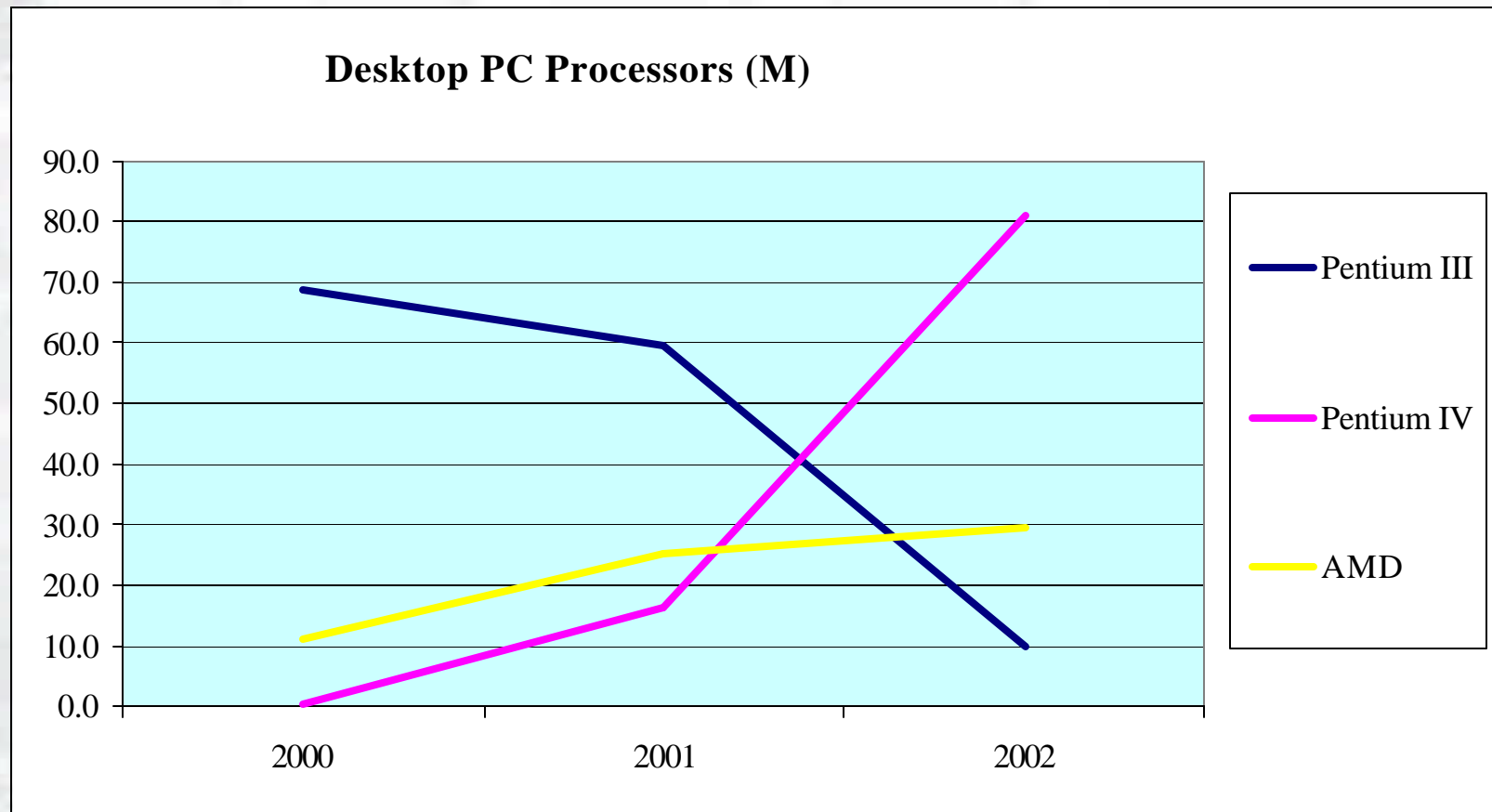
# Pentium 4 Rollout in 2001

- Memory and Chipset issues
  - Intel to release SDRAM/DDR chipset in 2H '01
    - If released late in 2H '01 could hamper MPU ramp-up
  - Third party SDRAM/DDR chipsets are expected, but no official announcements
    - If available in 1H '01 will help Pentium 4 ramp-up
  - Delay of Pentium 4 SDRAM/DDR chipset will retard MPU ramp-up and reduce forecast
- Slower Pentium 4 ramp-up provides greater opportunity for AMD

# Intel Process Migration 0.18 to 0.13

- Intel currently manufacturing on 0.18 micron
- Early 1H '01 Pentium III migrates to 0.13 micron
  - Enables faster Pentium III (over 1.1 GHz)
  - Learn new process for Pentium 4 migration
- Pentium 4 expected to migrate to 0.13 micron process by mid-2001
  - Improve yields
  - Lower power and higher frequencies (over 2.0 GHz)
  - Enables future mobile Pentium 4
- If process migration is delayed, Pentium 4 ramp will slow.

# Impact of Migration from Pentium III to Pentium IV



# Semico's PC Outlook

- Estimated 80M PCs in 2000 with P3 or AMD processors
- Forecast of over 85 million PCs in 2001 with P3 or AMD processors
  - P3 with .13 $\mu$  will migrate P3 to lower performance applications
  - Intel's chipset focus is on Pentium 4 applications

# Semico's PC Outlook

- We expect Intel will roll out P4 with RDRAM but will be forced to accept independent DDR chipsets in 2H01
- We also expect Intel's Brookdale PC133 chipset to support DDR by end of 2001
- Athlon/DDR shows very good system-level performance at a competitive price
- AMD performance also covers the gap between P3 and P4

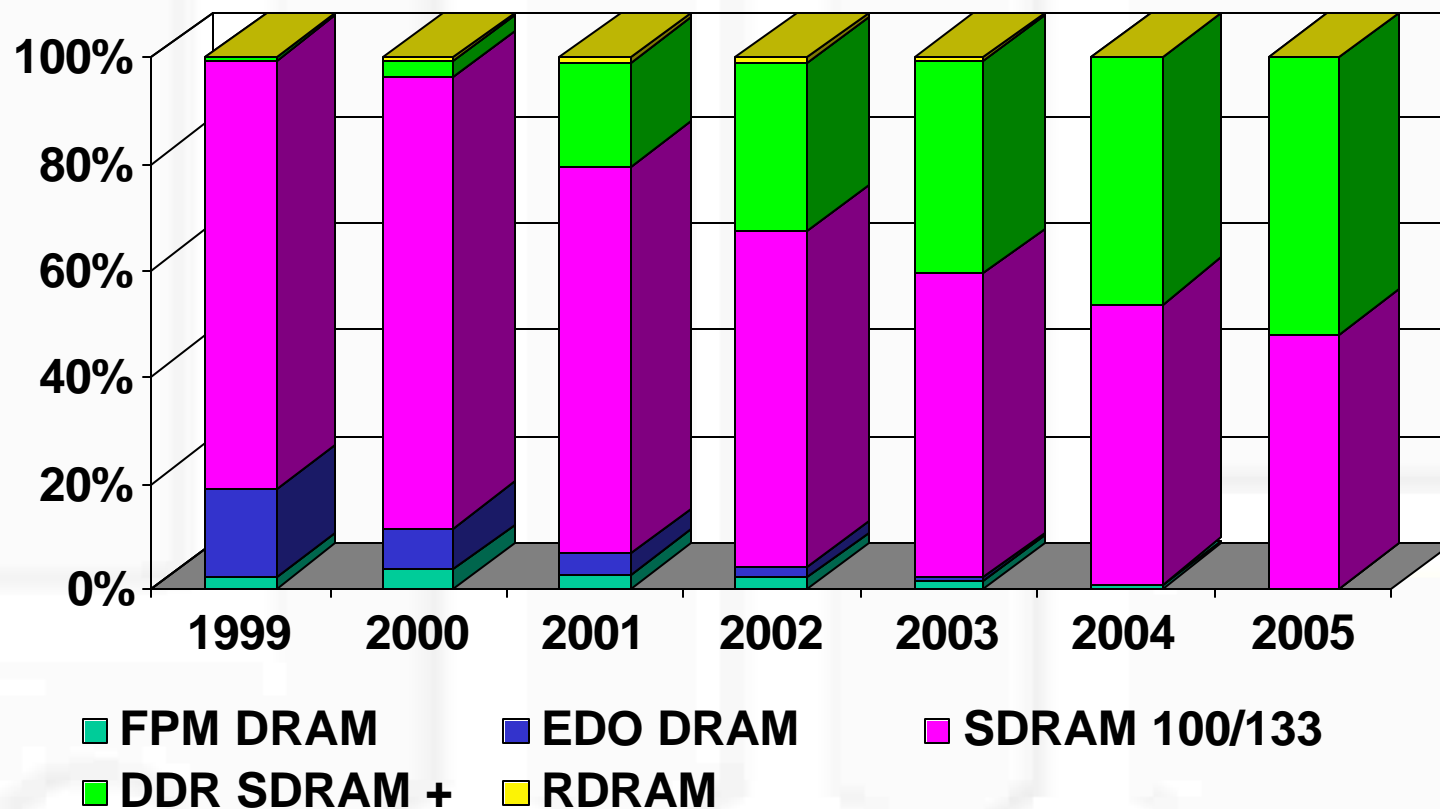
# 2001 DRAM Type Update

- DDR SDRAM ships in production volumes
  - Servers demonstrating DDR SDRAM systems
  - Delay in server chipsets will push out DDR SDRAM server demand to 1Q01
  - Majority of new designs for 2001 and beyond production expected to be DDR SDRAM
- RDRAM future still unclear
  - Plagued by high costs, low yield and limited number of suppliers
  - Major RDRAM rebates being offered tied to Pentium 4 rollout

# Evolution versus Revolution

- PC133 demand soaring with 815e availability
- DDR is metal mask option for PC133 for most DRAM manufacturers
  - More flexibility for manufacturing
  - Gains from existing PC133 yield improvements
  - Chipset availability limited, but increasing
- RDRAM demand is low –
  - success in workstation niche, Playstation 2
  - waiting for P4 Ramp

# DRAM Units by Type

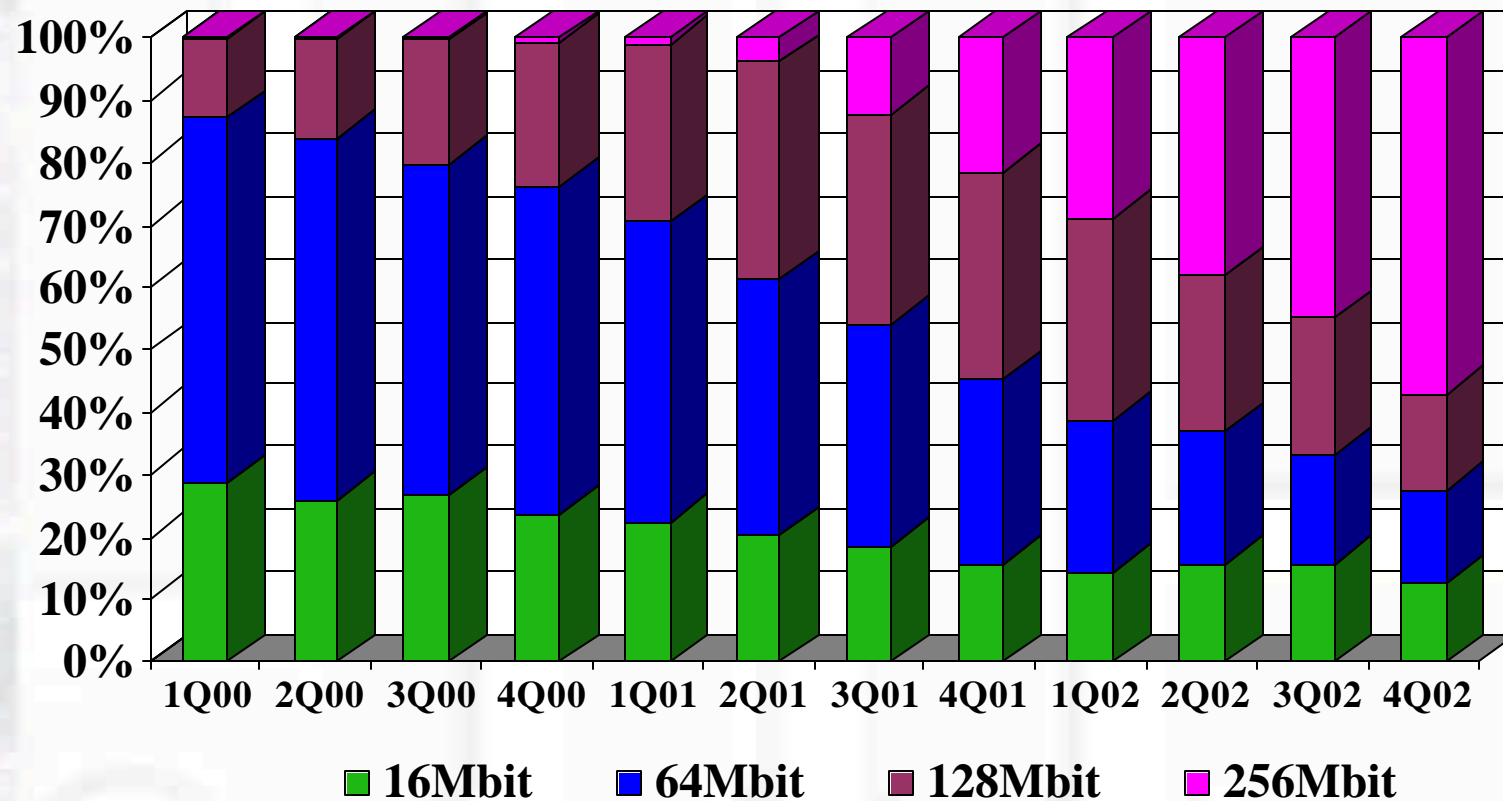




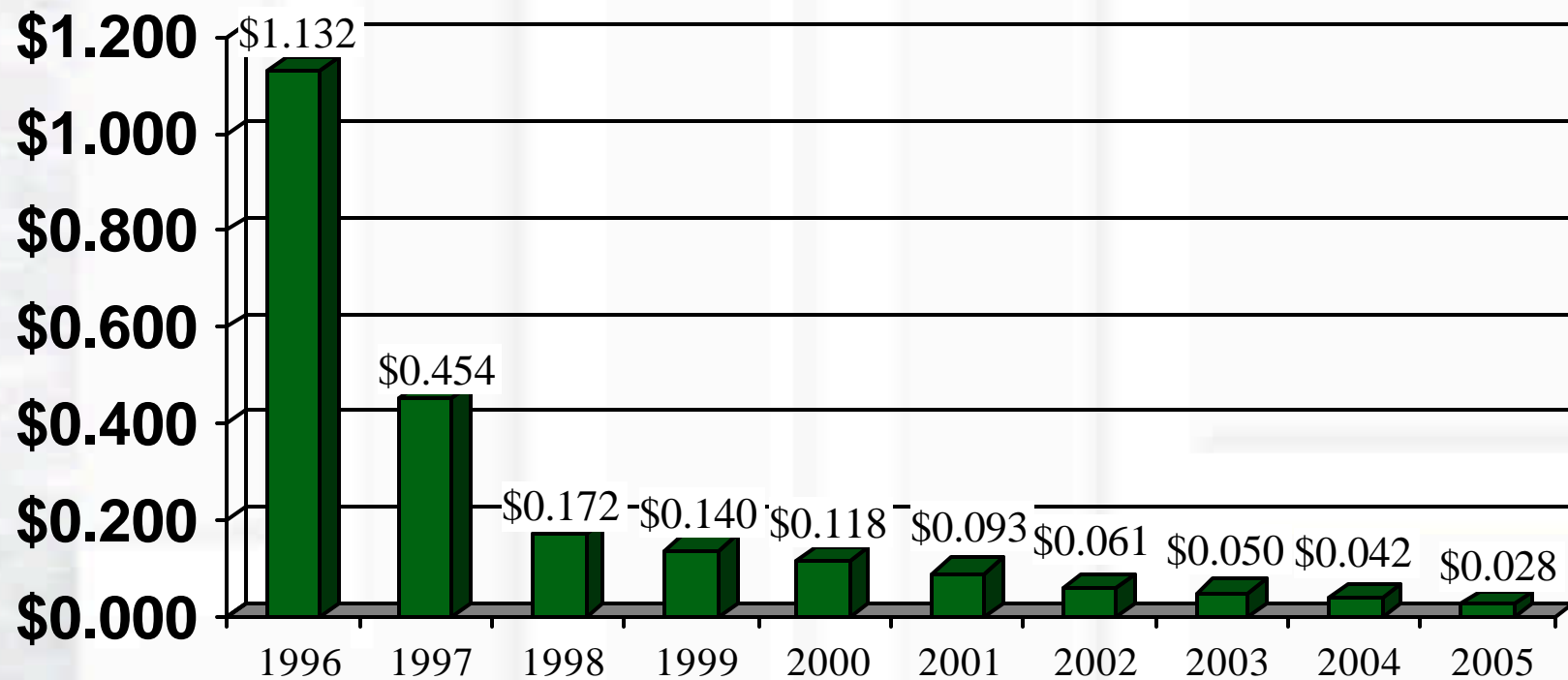
# DRAM Trends

- End Use Segmentation
  - Older types and densities still in demand
  - Supply uncertain for older types
- Desktop and Notebooks
  - Highest volume in low cost segment
- Internet—New Features and Functions
  - New convergent product—combined computing, communication in consumer box

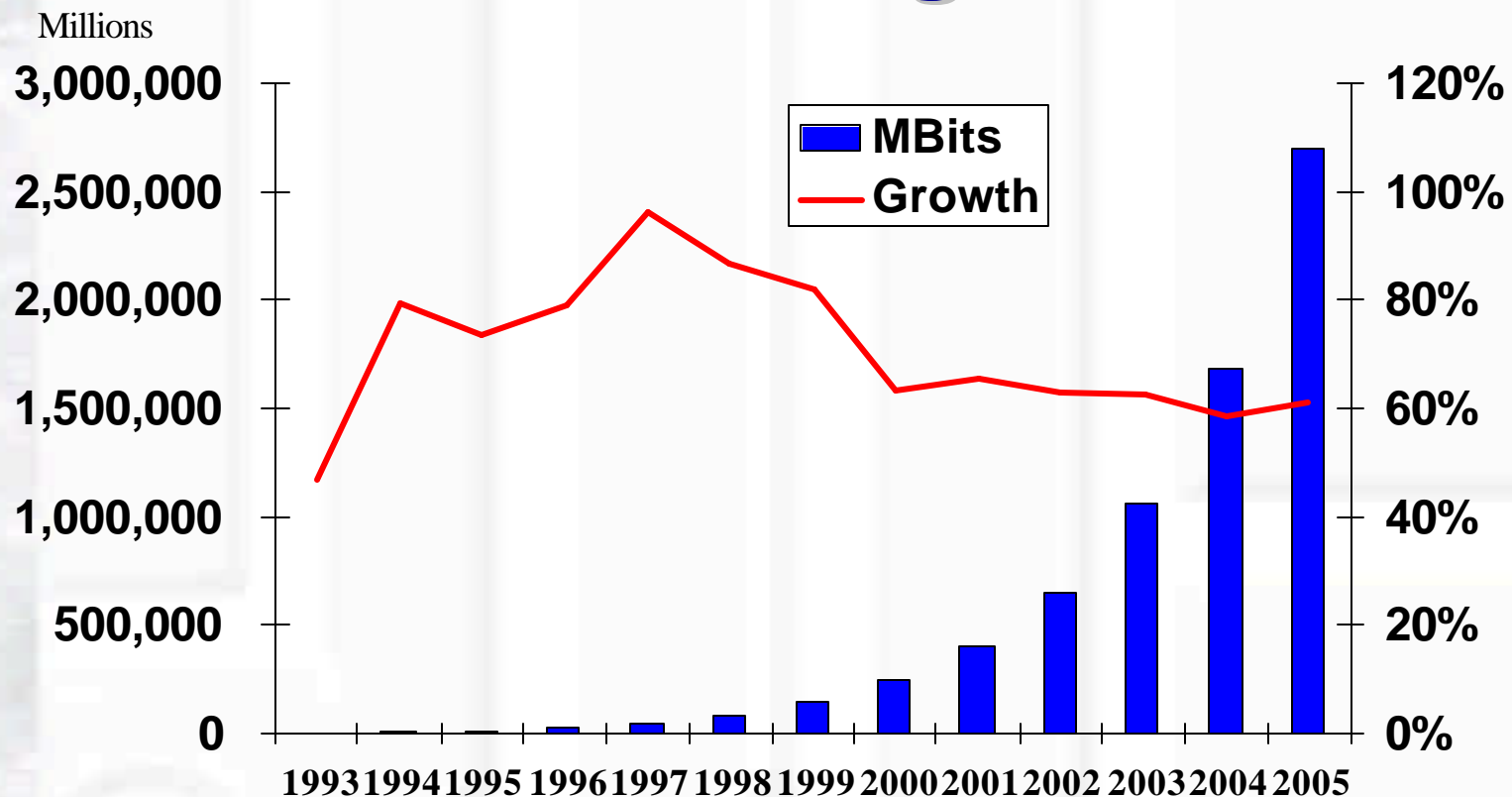
# DRAM Unit Density Migration



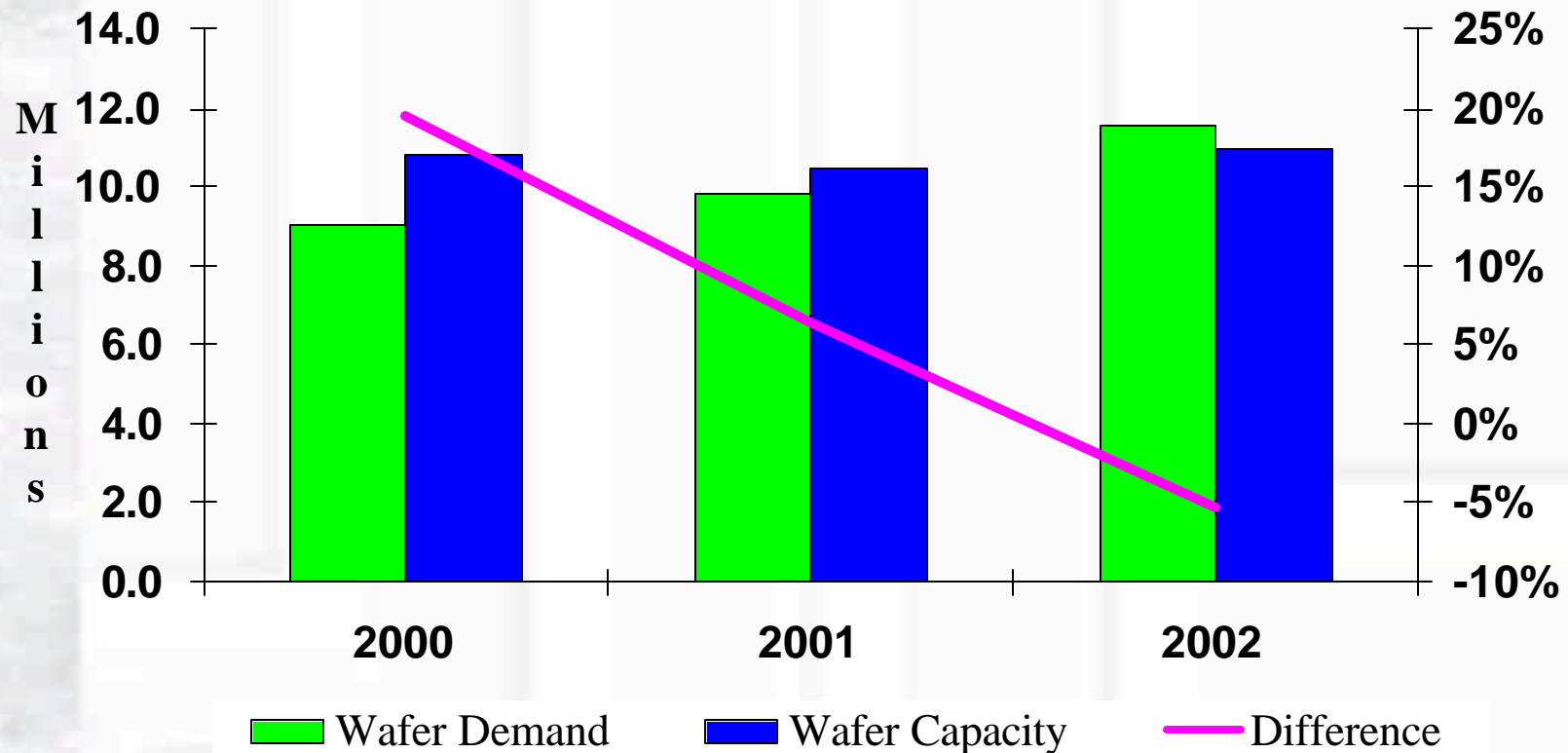
# DRAM Cost Per Megabit



# Megabit Shipments – Still Growing



# Wafer Demand and Capacity



# In Conclusion

- Expect the DRAM consolidation to continue until there are fewer than ten vendors. Consolidation may take until 2003.
  - DRAM vendors drop out as major capital investment becomes necessary and the segmentation of the DRAM market makes revenue generation more challenging.
- The cost of competition is too high to support numerous vendors.
  - Cost of 300mm production will limit number of vendors able to successfully invest.

# Yet Even More In Conclusion

- Chipsets are becoming a bigger issue for the computer market and DRAM vendors
- Both PC OEMs and DRAM vendors are dependent upon chipset availability
- Chipset designs control PC architectures
- Chipset features influence future PC concepts

# 2001 and Beyond

- Chipset—the new product differentiator